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The Relationship between Stock Prices and Exchange Rates: The Focus on Dar Es Salaam Stock Exchange (DSE)

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Abstract

This paper aims to examine the existing relationship between the prices of different stocks traded in the Dar es Salaam Stock Exchange (DSE) and the Tanzanian Shillings – United States dollar exchange rates (TZS/USD). In this study, we use the daily data sets covering a period of six years from August 15, 2011 through July 28, 2017 making 1455 observations. Vector Autoregressive (VAR) – Granger Causality model is employed accompanied with several tests conducted on the variables and the model itself. The findings conclude that, there is a short-term association between Stock Prices (SP) and Exchange Rates (ExR). Additionally, Stock Prices Granger Causes Exchange Rates as evidenced by Granger Causality and the Impulse test. These findings are supported by the fact that shocks in the Exchange Rates have no effect in the Stock Prices. This could mean that an investor can invest in short term at the DSE.

Keywords: Exchange rate, Granger Causality, Stock price, Impulse test

1. Introduction

The study of the relationship between stock prices and the exchange rates is challenging though interesting due to the fact that there is no common acceptable ground amongst economist as to whether stock prices really influence exchange rates and vice versa (Kutty,

2010).

Kutty (2010) argues that like prices of other traded assets, exchange rates are determined by number of factors such as expectation of the interest rate differentials between two countries, the current account deficit, external debt, and terms of trade, interest rate differentials, economic and political conditions. Kutty (2010) argues that the behavior of the stock prices is influenced by among other factors GDP, employment rate, interest rates, and performance of the company, exchange rates, inflation, trade balance and money supply.

Multinational corporations continue to invest in the emerging economies due to the opportunities and sweet attractions to investment presented such as few entry barriers to the capital flow, instable tax regulations, availability of raw materials and cheap labor force (Jayasuriya, 2009). Even though majority of the emerging economies have high political risk, multinational companies are willing to take the risk considering the profit they might realize if the business environment is calm. For this reason, multinational companies are not willing to consider long-term investment. This creates the need to comprehend the link between stock prices and exchange rates to find a better way to hedge against portfolio risk and protect the company's wealth (Kutty, 2010).

Therefore, this study intends to investigate whether there is a long or short-term association between the stock prices and the exchange rates and if any change in one of them can really affect the other. Granger (1969) causality test, unit roots and cointegration tests are employed all together. Tanzania being among the fastest growing economy in Africa attracts firms and investors from abroad to invest in its various economic sectors such as mining, agriculture, manufacturing, and transport to mention the least thus contributing to its foreign capital flow. For this reason, this study focuses on its stock exchange market the DSE that is located in Dar es Salaam the principal economic city of Tanzania.

This paper is divided into four parts. While the first and second parts consist of the introduction and relevant literature review respectively, the third part includes research methodology and the fourth part is about analysis of the results and conclusion.

2. Literature Review

According to Kutty (2010), "economic theory postulates that interest rates, inflation, price level and money supply and other factors are important variables in understanding the behavior of stock prices and predicting the trends and movements in exchange rates.

Hunjra, Chani, Ijaz, Farooq and Khan (2014) examined the impact of macroeconomic variables on stock prices in Pakistan by applying Granger causality and cointegration tests. The study findings concluded that in a short runs relationship between dependent and independent variables do not exist but in a long run. Additionally, they reported a significant long run association between macroeconomic variables on stock prices. The relationship between macroeconomic variables and exchange rates is supported by the studies done by Baillie and Selover (1987), Wolff (1988), and Ghartry (1998).

Kisaka and Mwasaru (2012) examined the causal relationship between foreign exchange rates

and stock prices in Kenya to establish the causal linkages between stock prices in the foreign exchange market and the Nairobi Securities Exchange (NSE). Their study findings concluded that the two variables are cointegrated and that the exchange rates Granger causes the stock prices in the Nairobi stock exchange (NSE).

In Ghana Adam and Tweneboah (2008) examined the impact of macroeconomic variables on stock prices by using Databank stock index and inward foreign direct investments, interest rate, inflation, crude oil prices and the exchange rate all representing macroeconomic variables. They employed cointegration test and vector error correction models (VECM) to analyze the above variables and found the existence of cointegration between macroeconomic variables and the stock prices however, VECM analysis showed that only lagged values of interest rate and inflation had a significant influence on the stock market.

Nyamute (1998) in Kenya conducted the study of the relationship between stock prices and other financial variables exchange rates included. The findings revealed the presence of a positive relationship between stock prices and exchange rates however, the validity of the findings were questionable due to fundamental methodological flaws in the study. That is because he used non-stationary series to run a regression analysis something that violates the classical theory of regression analysis with stationary time series thus can cause spurious relations that induce serial correlation which violate the basic assumptions for estimating the regression equation (Kisaka and Mwasaru, 2012; Olowoye, 1995; Granger, 1986; Phillips, 1986; Ohania, 1988).

Abdalla and Murinde (1997) used Bayesian Vector Auto-regression model (BVAR) to examine the interaction of the stock prices with the exchange rate among four countries namely India, Pakistan, Korea and Philippines. The study findings revealed that exchange rated effect changes in the stock prices of India, Pakistan and Korea but such relationship never observed in the stock prices of Philippines. In the study of the relationship between stock prices and exchange rates of the G-7 countries, Nieh and Lee (2001) could not find the evidence of long run relationship between the variables.

Ajay and Mougoue (1996) investigated the relationship between stock market and foreign exchange for Indonesia and Philippines markets and concluded that the causality runs from the stock market to the currency market but the evidence of causal relationship between stock market and exchange market in Hong Kong, Malaysia, Singapore and Thailand was never found.

In conclusion, empirical consensus on the relationship between exchange rates and stock prices in the emerging economies is still debatable and to date very few studies related to the financial markets present within the East Africa member states have been done as depicted in Table 1 below. This research intends to encourage more studies to be done within the region.

Table 1. List of Previous Studies Conducted within the East Africa Region

Sn	Author(s)	Tittle of the study	Model employed	Range of dataset	Results
1	Nyamute – 1998	The relationship between stock prices and other financial variables like money supply, interest rates, inflation rates and exchange rates in Kenya	Regression model	1993 to 1997	There is a positive relationship between stock prices and exchange rates. *(Questionable due to technical issues)*
2	Kisaka and Mwasaru - 2012	The Causal Relationship between Exchange Rates and Stock Prices in Kenya	Cointegration and error-correction models	November 1993 to May 1999	Exchange rates and stock prices are cointegrated; Exchange rates Granger-causes stock prices in Kenya.

3. Data and Methodology

3.1 Data

We use the "All Share Index" (DSEI) which encompasses daily closing prices of all stocks traded within the Dar es salaam Stock Exchange (DSE) and the Tanzania shillings against US dollar (TZS/U$D) exchange rate. Both series cover a period of six years from August 2011 through July 2017 making 1455 variables after adjustment and removal of incompatible data. The selected period has seen changes in some economic policies pursued by previous and current regimes, influx of foreign direct investments, mineral extract export ban and extensive public servant redundancy. The DSEI and TZS/U$D series will be represented by acronyms *"SP"* and *"ExR"* throughout this study. The period is chosen because during this time Tanzania as country has experienced a change in presidential system that has really affected the financial sector as well as private sectors that are listed under the DSE.

3.2 Descriptive Statistics and the Unit Roots Test

We use descriptive statistics to scrutinize the returns of DSE Index by calculating and interpreting the Mean, Standard deviation, Excess Kurtosis, Skewness, Maximum, Minimum, and the Jarque Bera at this stage. To test the stationarity of the observations and to check the evidence of long/short term association between the variables we employ the Augmented Dickey-Fuller (ADF), Philips Peron (PP), Kwiatkowski–Phillips–Schmidt–Shin (KPSS) and cointegration tests respectively as mentioned earlier. The test results are tabulated in the Table 2 below with interpretation underneath.

Table 1 and Figure 1 depict the descriptive statistics of the analyzed indices and their respective trends of returns. From Figure 1, we see that there is an upward and downward movement of both closing prices from 2014 onwards however, that was never the case prior to that year where a very small change was noticed. The differenced plot of both series shows

a white noise throughout (i.e. they exhibit several volatility clustering periods with the periods of large changes cluster together followed by the period of relatively minor changes). Noticeable minor break points on both indices can be explained by political tumultuous brought about by the general election, post-election events, Tanzanian legislative changes related to the mining sector and austerity measures pursued by the new regime.

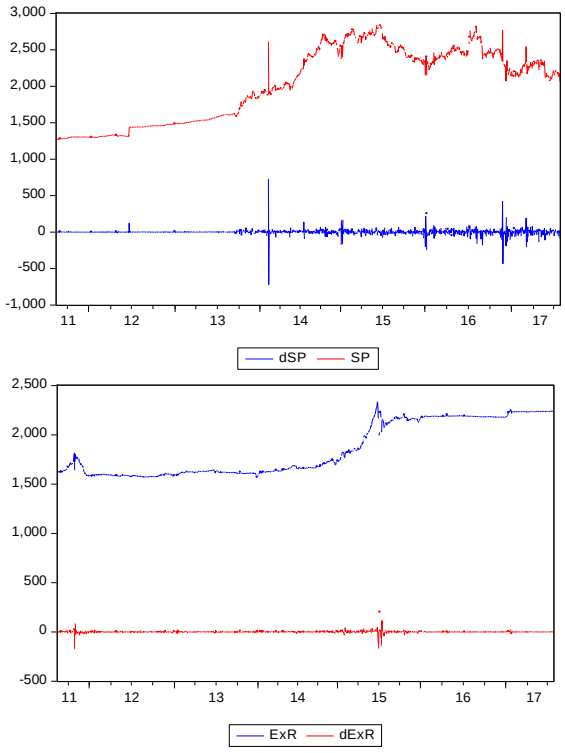

Figure. 1

The peakedness and tail of the distribution can best be interpreted by looking closer in their skewness, kurtosis values and the Jarque-Bera, which are computed by using following equations;

$$Std.Dev = \frac{\sqrt{\sum_{i=1}^{N}(y_i - \bar{y})^2}}{(N-1)} \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots(1)$$

$$Skew = \frac{1}{N}\sum_{i=1}^{N}\left(\frac{y_i - \bar{y}}{\hat{\delta}}\right)^3 \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots(2)$$

$$Jarque - Bera = \frac{N}{6}\left(s^2 + \frac{(k-3)^2}{4}\right) \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots(3)$$

Whereby "**s**" and "**k**" are skewness and kurtosis respectively.

Examining the values of kurtosis and skewness in Table 2, we see that both indices are

negatively skewed implying this distribution is asymmetrical with a long tail to the left (i.e. lower values). Additionally, they both have a kurtosis value greater than three i.e. "***k > 3"*** which is known as "*leptokurtic*" meaning that their central peaks are higher and sharper with longer and sharper tails as compared to Gaussian normal distribution. This could mean that observations close to the mean and extreme values are more frequent than that of normal distribution.

Table 2. Summary of the Descriptive Statistics

Variable	Average	Std. Dev	Skewness	Kurtosis	Jarque Bera	Prob.	Obs.
d(SP)	0.5453	43.2940	-0.0633	125.79	913419.10	0.0000	1454
d(ExR)	0.4349	12.2250	-1.6986	132.26	101156.00	0.0000	1454

Griffiths, Hill and Carter (1993) suggest non-stationary series to be differenced prior to running an econometric model. For this reason, our study applies Augmented Dickey-Fuller test (ADF) with long lags to test for unit roots since it is superior to other models as suggested by Schwert (1989). However, Phillips Perron (PP), Kwiatkowski-Phillips-Schmidt-Shin test (KPSS) and Break-Point test, will accompany the ADF test. Table 3 below shows the test results.

Table 3. Stationarity Tests

	Tests and Results							
	Stationarity Tests on Closing Prices							
	T-Statistics at 1% & 5% Levels			**LM-Stat**	**T-Statistics**			**LM-Stat**
Variable	**ADF**	**PP**	**Break Test**	**KPSS**	**ADF**	**PP**	**Break Test**	**KPSS**
SP	-3.4346 & -2.8663	-3.4346 & -2.8633	*-4.9491 & -4.4436*	0.7390 & 0.4630	-1.4926 *(0.5373)*	-1.5230 (0.5218)	-3.1930 (0.5703)	3.7060
ExR (TZS/USD)	-3.4347 & -2.8633	-3..4346 & -2.8633	-4.9491 & -4.4436	0.7390 & 0.4630	*-0.0234 (0.9553)*	*-0.2153 (0.9341)*	*-4.6377 (0.0294)*	4.0785
	Stationarity Tests on Return Series							
	T-Statistics at 1% & 5% Levels			**LM-Stat**	**T-Statistics**			**LM-Stat**
Variable	**ADF**	**PP**	**Break Test**	**KPSS**	**ADF**	**PP**	**Break Test**	**KPSS**
*d*SP	-3.4346 & -2.8663	-3.4346 & -2.8633	*-4.9491 & -4.4436*	0.7390 & 0.4630	*-31.1582 (0.0000)*	-67.4106 (0.0001)	*-35.7619 (<0.01)*	0.3330
*d*ExR (TZS/USD)	-3.4347 & -2.8633	-3.4346 & -2.8633	*-4.9491 & -4.4436*	0.7390 & 0.4630	-14.7485 (0.0000)	-34.4801 (0.0000)	-24.0585 (<0.01)	0.1814

Table 3 above depicts the results of the said tests on the closing prices and their respective differences. While the upper part of the table contains test results conducted on the closing prices, the lower part contains test results performed on the differenced series. We accept the null hypothesis of ADF, PP, and Break point test and the alternative hypothesis of KPSS. The entire closing price series have a unit root hence not stationary because The T-statistics and the corresponding probabilities at both first and fifth levels are not statistically significant.

However, we reject the null hypothesis of ADF, PP, Break point and the alternative hypothesis of the KPSS soon after differencing the variables indicating that we can use the differenced series in the modeling process.

3.3 Cointegration Test

Econometricians suggest cointegration model to find the evidence of the presence of long run association between variables and vice versa since this technique assist researchers to understand the relationship between variables (Kutty, 2010). Additionally, Banerjee et al (1994) argues, *"a series is said to be integrated if it accumulates past effects; such a series is non-stationary because its future path depends upon all such past influences, and is not tied to some mean to which it must eventually return."*

Regarding our study, this test will establish if it is true that changes in stock prices of the DSE here by represented by the "DSEI" have an influence to the changes in the exchange rate and vice versa. The test result shows that both equations are not cointegrated implying that long-term association between stock prices (SP) and exchange rate (ExR) does not exist but short term. We present the test results of the cointegration test in Table 4.

Table 4. Cointegration Test Results

Obs: 1434				
Series: *dSP dExR*				
Unrestricted Cointegration Rank Test (Trace)				
Hypothesized		Trace	0.05	
No. of CE(s)	Eigenvalue	Statistic	Critical Value	Prob.**
None *	0.123696	351.5949	15.49471	0.0001
At most 1 *	0.106976	162.2457	3.841466	0.0000
** denotes rejection of the hypothesis at the 0.05 level*				
Unrestricted Cointegration Rank Test (Maximum Eigenvalue)				
Hypothesized		Max-Eigen	0.05	
No. of CE(s)	Eigenvalue	Statistic	Critical Value	Prob.**
None *	0.123696	189.3492	14.26460	0.0001
At most 1 *	0.106976	162.2457	3.841466	0.0000
** denotes rejection of the hypothesis at the 0.05 level*				

3.4 Granger Causality

Granger (1969) proposed a statistical concept of causality based on liner regression modelling of stochastic processes that intends to see if both historical and current values of one variable say X_1 can assist to predict the prospect of another variable say X_2 (Seth 2007). According to Granger (1969), "if a signal X_1 Granger-causes a signal X_2, then past values of X_1 should contain information that helps predict X_2 above and beyond the information contained in past values of X_2 alone. He further suggested four definitions of causality related to price stock and the exchange rates two of them being in terms of stock prices (SP) to exchange rate (ExR) and exchange rates (ExR) to stock prices (SP) (Kutty 2010).

The linear regression model is preferred for the G-Causality modelling. Suppose X_1 represents stock exchange (SP) and X_2 the exchange rate (ExR), and then a bivariate linear autoregressive model can be represented as;

$$X_1(t) = \sum_{j=1}^{P} A_{11j} X_1(t-j) + \sum_{J=1}^{P} A_{12} jX_2(t-j) + E_1(t) \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots(4)$$

$$X_2(t) = \sum_{j=1}^{P} A_{21j} X_1(t-j) + \sum_{j=1}^{P} A_{22j} X_2(t-j) + E_2(t) \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots(5)$$

Where ***p*** is the maximum number of lagged observations, matrix ***A*** contains the coefficients of the model (i.e., the contributions of each lagged observation to the predicted values of $X_1(t)$ and $X_2(t)$, and E_1 and E_2 are residuals (prediction errors) for each time series. Suppose we reduce the variance of E_1 (or E_2) by including X_2 (or X_1) terms in the first (or second) equation, then we can say that X_2 (or X_1) Granger-(G)-causes X_1 (or X_2). In other words, X_2 G-causes X_1 if the coefficients in A_{12} are jointly significantly different from zero (Seth 2007).

Therefore, for a cointagrated variables, the VAR model which include the error correction term can be presented by the following equations

$$\delta X_{1(t)} = \beta_0 + \varphi_1(X_{1(t-1)} - \xi X_{2(t-1)}) + \sum_{i=1}^{P} \beta_{1i} \delta X_{1(t-1)} + \sum_{i=1}^{P} \beta_{2i} \delta X_{2(t-1)} + \varepsilon_{st} \quad \ldots\ldots\ldots\ldots(6)$$

$$\delta X_{2(t)} = \alpha_0 + \varphi_2(X_{1(t-1)} - \xi X_{2(t-1)}) + \sum_{i=1}^{P} \alpha_{1i} \delta X_{1(t-1)} + \sum_{i=1}^{P} \alpha_{2i} \delta X_{2(t-1)} + \varepsilon_{ft} \quad \ldots\ldots\ldots\ldots(7)$$

After running the VAR Lag Order selection criteria, lag eight (8) is selected as the appropriate lag based on the coefficients given by the model's test results thus viable lag for the causality test. The test results in Table 5 shows that there is only unidirectional causality i.e. exchange rates influence changes in the stock prices.

Table 5. Granger Causality Test Results

Dependent variable: δ SP			
Excluded	Chi-sq	df	Prob.
δ ExR	13.7564	8	0.0083
All	13.7564	8	0.0083
Dependent variable: δ ExR			
Excluded	Chi-sq	df	Prob.
δ SP	4.0816	8	0.8497
All	4.0816	8	0.8497

3.5 Response to Shocks

To check the contemporaneous response of changes in stock prices (δ SP) due to shocks in the exchange rates (δ ExR) and vice versa, we run the impulse response test and present the test results in Figure 2.

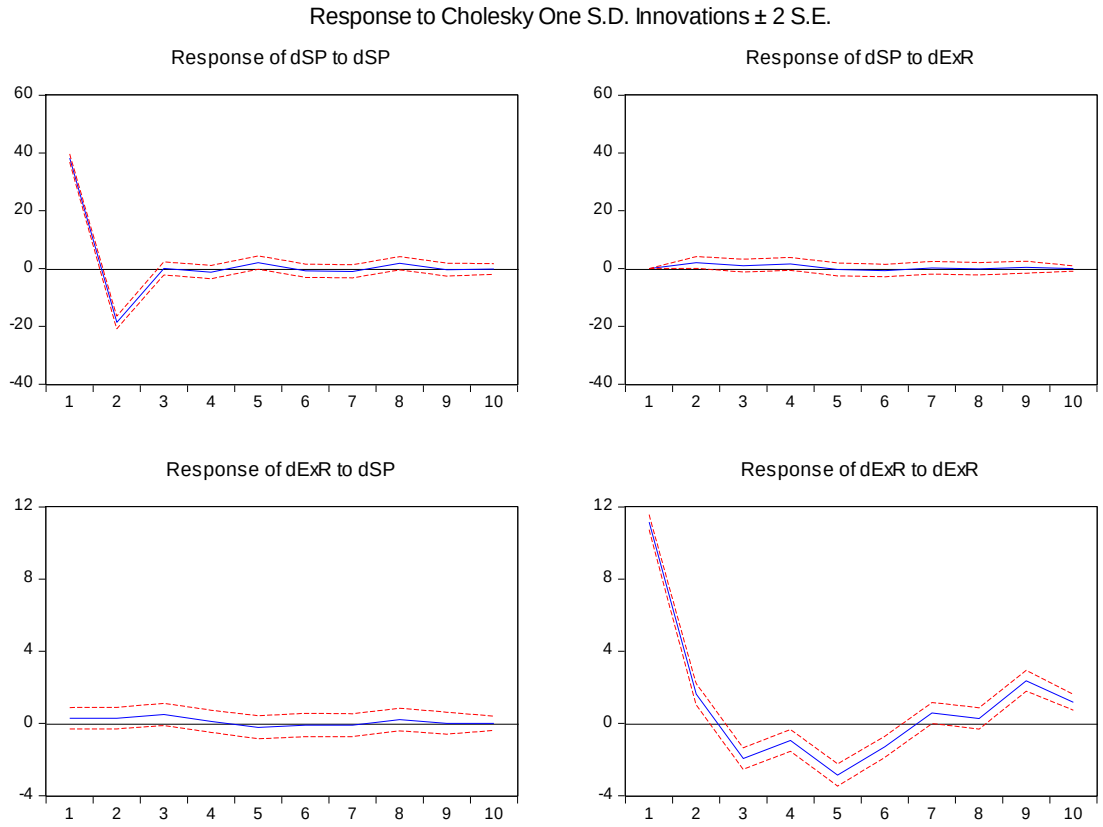

Figure 2. The Impulse Test Results

From the test results, we rule out that change in stock prices (δ SP) will be contemporaneous affected by shocks to the exchange rates (δ ExR) thus the curve representing the response of δ SP to δ ExR is forced to start at zero. This implies that shocks in exchange rates stay within the exchange rates. Conversely, we see that shocks in the stock prices effect the exchange rate since its curve is above the line at zero thus significant.

3.6 Diagnostic Test Results

Credibility of any model and that the output results may or may not be acceptable for further studies or policy implementation is supported by the diagnostic test conducted on such model. Figures 3 and 4 and Table 6 depict different diagnostic tests results performed on the model. We see that all residuals of the model are within the unit circle (modulus) none is beyond the standard error bounds as shown in the Figures 3 and 4. Moreover, we accept the null hypothesis of serial correlation LM test implying that residuals in our model are not serially correlated but independently distributed.

Table 6. VAR Residual Serial Correlation Tests

Null Hypothesis: no serial correlation at lag order h		
Included observations: 1436		
Lags	LM-Stat	Prob
1	3.044554	0.5504
2	1.871342	0.7594
3	6.044879	0.1958
4	2.691964	0.6106
5	7.262101	0.1227
6	4.422764	0.3518
7	4.970186	0.2904
8	3.504333	0.4772
9	3.349583	0.5011
10	6.639815	0.1562
11	2.551645	0.6354
12	2.423027	0.6585

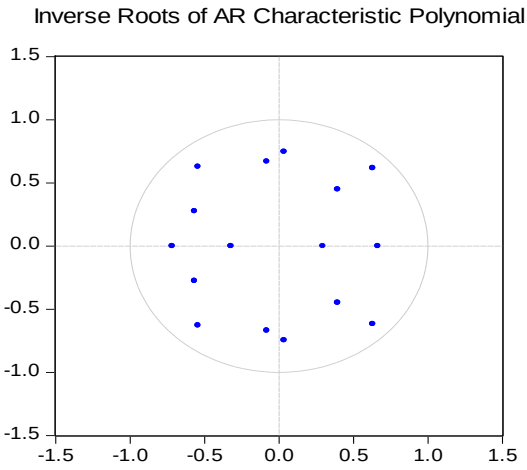

Figure 3

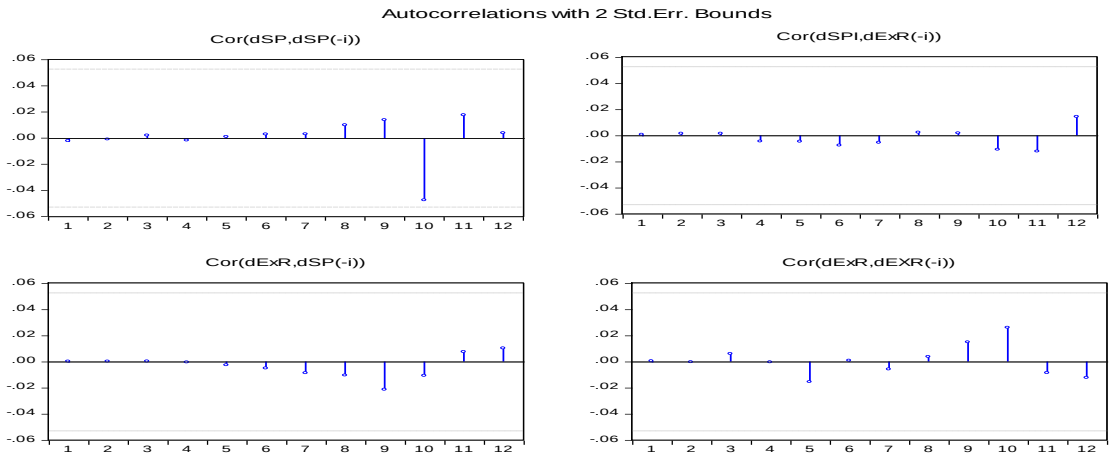

Figure 4. Autocorrelation Test Results

4. Conclusion

In conclusion, the study findings collaborate the finding of Kutty (2010), Nieh and Lee (2001) and Bahmani et al (1992) that long-term relationship between stock prices and exchange rates does not exist. Furthermore, stock prices Granger cause exchange rates in short term only as evidenced by the Granger Causality test and also concluded by the findings of Abdalla and Murinde (1997). Since any applied stock market regulation policy will have only a short-term implication on the exchange rate, we counsel Tanzanian policy makers to be cautious during monetary policy formulation and when executing such policy.

Additionally, the findings will assist various investors of the DSE to comprehend the existing relationship between various stocks traded within the market and the exchange rate thus be in a positon to make viable short-term investment decision worth their funds.

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